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Composite Photography applied to Handwriting. By Dr. Persifor Frazer.

(Read before the American Philosophical Society, January 16, 1886.)

The following preliminary note on this subject appeared in the Journal of the Franklin Institute for February, 1886 :

Francis Galton was the first to point out in fugitive memoirs, and notably in his important work, "The Human Faculty," that one could sift the common from the accidental features of a number of objects by exposing them in succession to a sensitized plate in such a manner that the images of the similar parts of the different objects should occupy as nearly as possible the same parts of the plate ; and that each object should be exposed for only a fraction of the length of time necessary to complete a picture on the film used. This fraction depended generally, if not always, on the number of objects and on the sensitiveness of the film. For example, if there were eighteen objects and the plate took thirty-six seconds to develop, each object would ordinarily be exposed for two seconds. It is easy to see that the result in the finished picture would be that those features which all the objects had in common would be re-enforced by each separate exposure, whereas those features which were accidental or variable, and which would be different for every individual, would be exposed for but two seconds and would be so indistinct as practically to fade away. Where the object was to catch a family likeness by exposing all the members male and female to the same portion of the plate, the result is a curious medley of faint whiskers and moustache ; of hair parted in the middle and at the side ; of female gowns with buttons to the throat and of male shooting jackets thrown open. But out of all this faint halo of confusion and blur, there starts a characteristic face which is the family type. Very often, too, this type-face resembles noticeably two different members of a family between whom no one can find a resemblance. It is this latter fact (which might have been expected) that induced me to look to the process for aid in solving the problem of identity of origin in handwriting. When a number of animals of the same race are thus treated, the method secures the fixing of the race or family characteristics, etc., as the case may be. When a number of pictures or coins bearing different representations of the same individual or scene are the objects, the result is to obtain either the average appearance of the same thing under different conditions (as for instance a man at different times of life), or the average of the impression made by identically the same thing on different artists. In this case, the merit of the process is that it constructs its image out of all that many pairs of trained eyes have seen, without giving undue weight to any one pair. So far, then, these efforts have been directed to re-finding a lost or concealed existence through multiple testimony, very much as the law tries to get at the truth by examining a number of witnesses.

At first sight one would suppose, however, that the case of handwriting

was a different one, but I think that the analogy with the above cases will appear strong on due reflection. With a given mental image of what one desires to write before one; and with a given relation of will-power, nerve sensitiveness and muscular force, the same signature could be repeated a thousand times, provided that all these conditions were invariable, and no others were superadded. So far from this being the case, however, every one of the factors just named which produce a signature, depends on physical and mental—in other words, on extraneous influences, to a very large degree. The movement commenced to effect an up stroke is met by an unexpected obstacle in the paper, a slight twinge in the shoulder, or a sudden noise, and the resulting line would show (were we sufficiently cognizant of the detailed working of all the complicated parts of our mental machinery to interpret it) just the order in which our different sentient and executive functions have been affected, and to what extent. But while these ever-recurring accidents result in preventing any signature from being made exactly as intended,* the fact that no two of them effect the same kind or amount of deviation leaves it in the power of the experimenter to extract from this process the “ideal” signature—a signature which probably never was seen as it appears, and yet which so combines all the visible results of a particular will acting on a particular arm to trace on paper a known design with a pen or pencil, that it may justly be called the *type* signature of that writer. What was said of the resemblance of every object of a group of objects which have any claim to be associated together, to the composite made of that group, even though it differ widely from other members of the same group; is true of handwriting. It has been remarked that the composite signature is an ideal, and never was realized. This is because the lines along which the strongest re-enforcements are made are those where locally varying deviations most frequently cross. To put it in another form, suppose the lines *a*, *b*, *c* and *d* to be in agreement as follows: At the point *a'*, *b* does not cross, but *c* and *d* do. At *b'*, *c* does not cross, but *d* and *a* do. At *c'*, *d* does not cross, but *a* and *b* do. The line which would represent to the eye part of the ideal signature, would be that traced the points *a'*, *b'*, *c'*, *d'*, because those points having superposed lines of three out of the four signatures and would be darker, while the variations at each of these points would be indistinct.

In examining with care a composite signature as just described, it at once arrests the attention that the variations are not equally distributed over the entire body of the letter, but that there are regions of each letter where variations of a particular kind are noticeable, and other regions where there are few or none. The more the manuscripts of an individual are compared the more forcibly does this fact appear, until finally one is tempted to conclude that after a handwriting is once formed, it cannot

*The word “intended” is used to imply the effect which would be produced by the action of the will through the hand on the paper if not modified by these accidents, and not solely conscious intention.

naturally exhibit deviations except within a defined variation and in certain limited areas adjacent to the separate letters. It is thus as great an assistance to the observer to study the variations, as to study the ideal signature. Indeed, the variations are all important in the matter of identification, and if there were no variations the method would be inapplicable, because an exact copy might be made by tracing. A comparatively small number of signatures will give the maximum and minimum of variation in any given region of one of the letters forming it. Moreover, the kind of variation is easily observed where there are a number together, so that the most perfect adept at forgery could hardly hope to simulate the microscopically minute characteristics of variations which are simply the visible expression of a series of indefinitely complex relations of muscle and nerve.

In a case which was recently brought before the Orphans' Court in Philadelphia, this principle of composite photography was for the first time applied by me to the purpose of identifying handwriting, and from the experience thus far gained, it is thought that it will (at least in many cases) more surely lead to the truth than will the mere opinions of the most skillful expert.

Philadelphia, January 19, 1886.

We judge of force and weakness ; of the stability and instability ; of expression and character chiefly by applying the experience that we have gained through the observations of our lives to the images we see before us. In the more complex studies of nature the image is rendered in colors and their shades, and all these increase almost indefinitely the delicate phases and modifications of the thought which is suggested. They are just so many words added to the language in which external nature speaks to us.

But an almost infinite number of facts are impressed on our minds with convincing force without recourse to other than the plainest and simplest combinations of lines. A being, whether civilized or savage, recognizes instantly the impossibility of a tree growing with its roots in the air, or a man standing on the vertical face of a wall. The French caricaturists have demonstrated how much of character and expression may be given by a few lines which when looked at minutely resemble the scrawls of an infant on a sheet of paper, yet when viewed from a certain distance in its general effect tell us a whole story without the use of a word. It is undeniable that the power to do this is based upon the fact that certain accentuated lines appear in the figures of men and things under a given set of circumstances, and by taking these and omitting all else we have a sort of skeleton image divested of unessentials. This skeleton image is in its way a sort of composite, arrived at, it is true, by a different method from that here employed, but nevertheless representing the sum of the artist's experiences in a great many more or less similar cases, and the greatness of the historical painter lies just in his power to represent an important event or

crisis by the effects which it makes visible on those who are participators in and spectators of it. Here is no place to admit variation, the attitudes, or, in other words, the lines of the figures in such a composition must be normal and intelligible to the mass of mankind; must be, in short, a composite or abstraction of the lines that would survive were a hundred thousand such scenes to be instantaneously photographed: all else weakens the effect intended. Composite photography is a method of obtaining the essence of a number of objects and, in so far as those objects are typical of similar phenomena, of recording the relations of things to each other, the effects produced by a certain force or certain forces on matter. The composite will enable the mind, armed with some experience in life, to ascend from the individual cases to the underlying cause or motive.

Is it necessary, then, to prove that a line made by a human arm and hand is liable to the variations which such an arm or hand must produce when influenced, as they always are, by indefinitely numerous physical and mental forces? Is it necessary to devote much time to the proof that a line on paper so produced is as much a resultant of organic processes as the outline of the human figure or the expressions of the human face? It is a kind of fossil like the print of a footstep or of a leaf which, while it consists of nothing having life, or that ever need have had life, and possesses none of the material of the body which made it, is capable like the impressions above referred to of telling a great deal of the characteristics of its creator: it is, in fact, as organic as the forms of living things by which we judge them, for their forms or images do not possess life either.

Such methods as composite photography, or composite drawing or painting of any kind which can be accomplished when the hand has the skill to reproduce what the memory has stored away, are applicable only to the representation of resultants which do not vary within too wide limits, and are especially applicable where such variations depend upon the influences brought to bear on sentient things, and when they do not occur *per saltum*, but gradually and by imperceptible steps.

If the purpose be to represent an average of some object which presents images differing radically from each other at successive views there must be a very large number of such images selected to photograph, and then an ill-defined but darker blur will show vaguely on what part of the field on the whole the images have been most numerous. For phenomena of this kind the method is not adapted to offer its best results, though it still may be used to ascertain some facts in a general way.*

The attempt to apply the composite system of photography to the curves representing the rate of mortality in cities and towns, or to the

*In a pleasant letter received from Mr. Francis Galton, F. R. S., in answer to a copy of the preliminary note given above, which I sent him, he mentions that an attempt was made at the Kew Observatory to apply the principle of composite photography to the meteorological charts, without great success, though with more than Mr. Galton would have anticipated.

changes of the weather, &c., &c., is not likely to be rewarded by striking results, except to the extent which I have stated above, because these curves are composed of data taken at such intervals of time that there is no necessary sequence between them ; they are affected by causes which are in no respect to be likened to the gradual unfolding of human expression by relaxations and constrictions of the muscles, the sum of all the changes not perceptibly altering the field first obtained, but altering the "values," as the artist calls it, or the relative importance of the rôles assumed by each unit of the image to the rest. These changes are as characteristic and delicate in the line made voluntarily by a living being as in the lines which its form involuntarily makes on the retina, and therefore one set is as susceptible of concentration and averaging as the other.

The merely formal and always repeated parts of a letter or other document have an entirely different character value from those parts which are composed of words and letters thrown together to represent a certain state of things, and which may never be repeated in exactly the same order. Obviously no composite of phrases can be expected unless the phrase have a technical significance, but separate words can be selected to form bases of composites, or even the two or three words which enter into an idiom, one of those well-trodden short cuts of language to a given idea. Such partial phrases (rendered frequently in other languages by a single word), as "in order that ;" "as well as ;" "not only ;" "but also," &c., will be found in the handwriting of any one accustomed to write much, and may be taken as elements out of which to construct composites of the words of which they consist ; but the value of such elements in helping one to a knowledge of the character of the person who penned them, or even of the general character of the writers' handwriting is not as great in these cases as it is in the signature and the few formal words which precede it in a letter. There are several reasons for this ; one is that these formulas occur in different connections with the accompanying text, indicating very different attitudes of mind in the several cases. The sense of what is written must have a large influence in the manner of writing it, and therefore the letters composing these words will be larger or lighter ; or more or less quickly and angularly written as the idea of the sentence by reflex action evokes different emotions in the mind of the writer. A circumstance equally noticeable will be the place on the paper which the words occupy ; whether there is an abundance of room to write the words, or whether they are cramped in order to bring them into a smaller space. In cases where the words of such a subphrase are divided between two lines, they will almost surely not appear as they would when they follow each other in their natural order. But more even than these is the fact that the signature and its connected words, "Yours truly," &c., are always indicative of the task completed, the information conveyed. They are words of ceremony and endorsement, no matter what the contents of the letter may be. They are invariably repeated and come to be a purely conventional sign, of which the

parts resemble more or less the letters in the body of the writing in different people. This symbol usually occupies very nearly the same part of the page—at least as to its distance from the right or left hand edge of the paper—and this tends to fix it as a distinguishing sign. All these facts lead to a distinction between a signature, and that writing by the same hand which accompanies original composition.

There are, of course, peculiarities in every hand which can be traced both in the signature and in the body of the text. Such are very apparent when the writer labors under a physical disadvantage, such as a maimed or deformed hand or arm, but in lesser degree these peculiarities are present in every handwriting and constitute the general constant of “will-power, nerve sensitiveness and muscular force” employed by a given individual in this perfunctory habit.

I say *general* constant to imply that this relation must be regarded without paying too much attention to detail, for probably on no two occasions of a man’s life do these factors exist in him in *absolutely* the same proportions, and even if they did, the least change of environment would alter the results thus accomplished. But the signature of a man being divested as much as possible of the accidents due to his outside influences, it follows that the signature is the production of his hand least likely to yield an insight into his condition when writing it. On the other hand, the fact that he selects one particular way of expressing his identity bestows upon it something of a resultant of the various motives which actuate him, and makes it a sort of digest of the points of his character called into play in the performance of the act. We may look for the same sort of character in a signature that we find in a photograph or a picture, and the same causes may prevent either the one or the other from faithfully representing the peculiarities of the individual, by representing that individual as he appears when conscious that he is being observed; or, in other words, a character is assumed which corresponds to the taste of the individual and represents more or less how he would like to be seen by the public. When the character is observed to exist throughout the entire mass of his writing, it may be assumed that it represents accurately the man, for no amount of patience and study would enable one to retain such peculiarities under all the varied circumstances attending the act of writing, if it were not inherent in the individual himself. In any case, however, the result is a likeness which all who know the original will recognize, even though one or two features may be made more prominent in pose than in repose, and that constitutes the chief value of the analysis of signatures for identification independently of what we may learn from them of the mental attributes of their signers.

It is not so very entirely obvious how signatures with many light flourishes, or accompanied by intricate lines connecting their several parts, should be superposed, for these appendices are so easily affected by minute causes that it seldom happens that two will cover each other exactly. It is not to be expected that such parts will survive in the resulting type signature, but the breadth of the space covered by the blur and parallelism of the

faint lines will give evidence of the extent to which these ornaments have grown from caprice to a habit.

As a general rule there are several places—sometimes as many as eight or nine in a long signature—when the darkening of the lines indicates a general conformity of the pen's path to one direction, and it would seem that these places were not peculiar to any one part of a letter, nor that they were less in a hair line than in a heavy stroke. They appear to be dependent upon the anatomy and muscular structure of the individual in connection with his method of performing the act of writing his signature. For instance, some writers can only form one or two letters without moving the writing hand ; only a word or so without shifting the elbow ; others describe with the forearm of the writing hand a curve around the elbow which remains stationary ; others slide the forearm along into parallel positions while writing. All these habits have different effects upon the handwriting which results, though they are not always to be easily detected, owing to the fact that other habits are cultivated at the same time to counteract the defect which each of these methods, when not so compensated, would have impressed upon the appearance of the chirography.

Thus, he who writes with an elbow pivoted immovably upon the table must learn to move the fingers over a greater space at some part of the line, to avoid the curve which would unconsciously result. This more vigorous movement of the fingers is likely to produce heavier strokes in the part of the signature where the compensation is naturally applied. So that a fixed elbow and heavy letter in the middle of the signature may stand to each other in the relation of cause and effect.

In signatures when the divergence is wide and the agreement correspondingly small, it has been my custom to use the dark portions as centres to adjust the various signatures on, and this plan will sometimes furnish a good composite when other plans fail.

Desiring an illustration to accompany this paper, I sought a signature which would serve as a fair test of the process. Manifestly such a signature must be well known to a large number of persons, and enough examples of it must exist to bring out the type character of their combination. Those individuals whose signatures are known to the largest number of persons are usually bankers or persons authorized to sign firm drafts, checks, &c., and these not unnaturally object to having the minutest characteristics of their writing brought to the knowledge of the public, though for the reasons stated above a study of what the composite teaches would convince the intending forger that his task was a far more difficult one than that of simply reproducing a design. On the other hand signatures of dead bankers and dissolved firms soon pass out of the remembrance of those who were once familiar with them, and therefore have no more significance than the sign manuals of unknown writers, or those which are purely fictitious.

George Washington's signature was one of the first to suggest itself, because many persons were familiar with it, and there are numerous

well-authenticated documents in existence which bear it; but it has proved to possess other advantages which were not known when it was selected. As in everything else, Washington was deliberate, painstaking and uniform in his method of writing his signature and the consequence is that it makes an excellent composite for illustration.

In writing his signature Washington put pen to the paper five times. First he wrote the "G W" in one connected line. Secondly, he raised his hand and made the small "o" between the upper parts of the G and W, and the two dots which appear in all but signature No. 7. Thirdly, his hand and arm were placed in position to write "ashing," these six letters occupying a breadth of almost exactly $1\frac{3}{4}$ inches in every signature except the third, when they are extended to $1\frac{1}{2}$ inches. This is about as much of the arc of a circle (of which the centre is the elbow pivoted on the table) as one with a forearm of average length can cause to coincide with the tangent, or the straight line across the paper which the lower parts of the letters follow, unless unusual effort be made and a great deal more movement be given to the fingers. The "g" ends in a curved flourish, of which the convex side is turned upwards below the right centre of the name. [NOTE. The lower loop of the "g" in all the signatures and in the composite was cut off in preparing the plate.] Fourthly, he wrote the final "ton." Fifthly, he added the very peculiar flourish above the right centre of the name, with the object of dotting the "i" and crossing the "t" at the same stroke.

In examining the composite, the effect of these various separate movements becomes manifest in its strengthened portions. It is hardly possible that any one during the period of sixteen years, which these signatures represent, or from 1776 to 1792, should have so schooled his hand to write a long name that the first inch or so of the writing should always occupy the same relative position to the body of the signature. It would take at least that much action for the hand and arm and pen to be brought into normal signature-writing condition; and especially is this so when this part of the writing is accompanied by flourishes as it is in the case we are considering. The "G W" and the little "o" and the dots at the top were the prelude, after which the arm was moved into position to write the main body of the signature or the "ashing." Of course, from the manner of making the dots, and the extremely small space they cover, their re-enforcement of each other in the composite was almost impossible, and, in fact, like other subordinate characters, they disappear almost completely. This latter is the part of the name which one would have expected to exhibit the greatest amount of uniformity, as in point of fact it does, with the exception of its terminal "g," which shows more variation than any of the other letters, because at this point the limit of coincidence between the tangent line of the writing and the curve, of which the right forearm was the radius, had been passed, and a freer movement of the fingers was compensating for the increasing divergence. [NOTE. It is likely that Washington sometimes raised the hand between the end of the long "s"

1

G. Washington

2

G. Washington

3

G. Washington

4

G. Washington

5

G. Washington

6

G. Washington

7

G. Washington

8

G. Washington

and the beginning of "h," but he does not appear to have moved the elbow. All but the second signature are consistent with this view, and in the 1st, 3d and 5th it is plainly indicated. In the others, as in the flourish above the sixth signature, the pen may not have marked.] The fourth separate act of the penman was the formation of the "ton" after a movement of the arm. The breadth of the space occupied by these three letters is from $\frac{5}{8}$ to $\frac{7}{8}$ of an inch, or considerably within the range of coincidence of the curve and straight line before referred to; and owing to this fact there is only a moderate degree of re-enforcement of the letters in the composite, because these letters might fall into the first or last parts of the 2-inch space which was the limit of movement with a fixed elbow. It is worthy of note that even in this case the middle letter of the three is darker in the composite than either of the outside letters. The fifth and last movement was the flourish which dots the "i" and crosses the "t" by one stroke. This was done in the freest of free hands—often, as it seems probable, without resting hand or arm on the table at all. Therefore there is no coincidence of the lines in this part of the composite and the *region* of variation is wider than that of any other part of the signature.

All the signatures used in the accompanying plate (seven in number) are unquestionably genuine. With the exception of one, which is the property of the writer, they were carefully chosen from a number of authenticated signatures in the possession of the Historical Society of Pennsylvania.

No. 1 is on a letter, dated December 18, 1776, from near the Falls of Trenton, and addressed to Washington's brother Samuel.

No. 2 is on a letter dated Headquarters, November 4, 1777, and is addressed to the writer's great-grandfather, Lt.-Col. Persifor Frazer, then a prisoner of war in Philadelphia.

No. 3 is on a letter dated September 27, 1777, and is to Wm. Henry, of Lancaster.

No. 4 is the Composite of all the rest.

No. 5 is on a letter dated Headquarters in Morristown, February 22, 1777. The person to whom the letter was addressed is not stated.

No. 6, dated September 26, 1793, is affixed to the commission of David Lenox.

No. 7, of the same date, is affixed to David Lenox's appointment as agent for the relief and protection of American Seamen.

No. 8, dated May 24, 1799, closes a letter to Thomson Mason.